Navigating the data center sector

Key trends, opportunities, and challenges for utilities

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E Source

We know utilities.

June 12, 2025

Speakers

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Today's discussion

- Review the data center landscape and impact to utility strategy
- Highlight utility opportunities and challenges
  - Economic development and load forecasts
  - Time and path to power
  - Renewable and net-zero targets
  - Energy efficiency and load flexibility
  - Impacts to other retail and low and moderate income (LMI) customers

Data centers and their energy use are the talk of the town

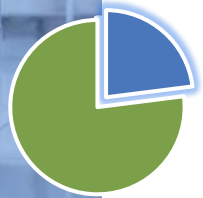
- “AI, data center load could drive ‘extraordinary’ rise in US electricity bills” —Utility Dive
- “Data centers are driving US power demand to hard-to-reach heights” —Canary Media

Source: Microsoft stock images

A recent EPRI study of 25 utilities indicated...

60% of utilities with interconnection requests > 500 MW

48% of utilities with interconnection requests > 1 GW



23% of utilities with total requests > current utility peak

Source: Microsoft stock images

Source: Utility Experiences and Trends Regarding Data Centers: 2024 EPRI Survey

AI and LLMs are changing the energy and computing landscapes

Futurism

Sam Altman Admits That Saying "Please" and "Thank You" to ChatGPT Is Wasting Millions of Dollars in Computing Power

"You never know."

Source: Futurism

Recent Ask E Source topics about data centers

- Improving economic development
- Forecasting load growth
- Energy efficiency opportunities
- Demand response and load flexibility options
- Reducing impacts to other retail and LMI customers

Poll: Which topic is the biggest challenge for your utility?

1) Forecasting data center growth
2) Data center account management and economic development
3) Data center load flexibility (or lack thereof)
4) Finding energy efficiency opportunities for data centers

Poll results

Panel discussion

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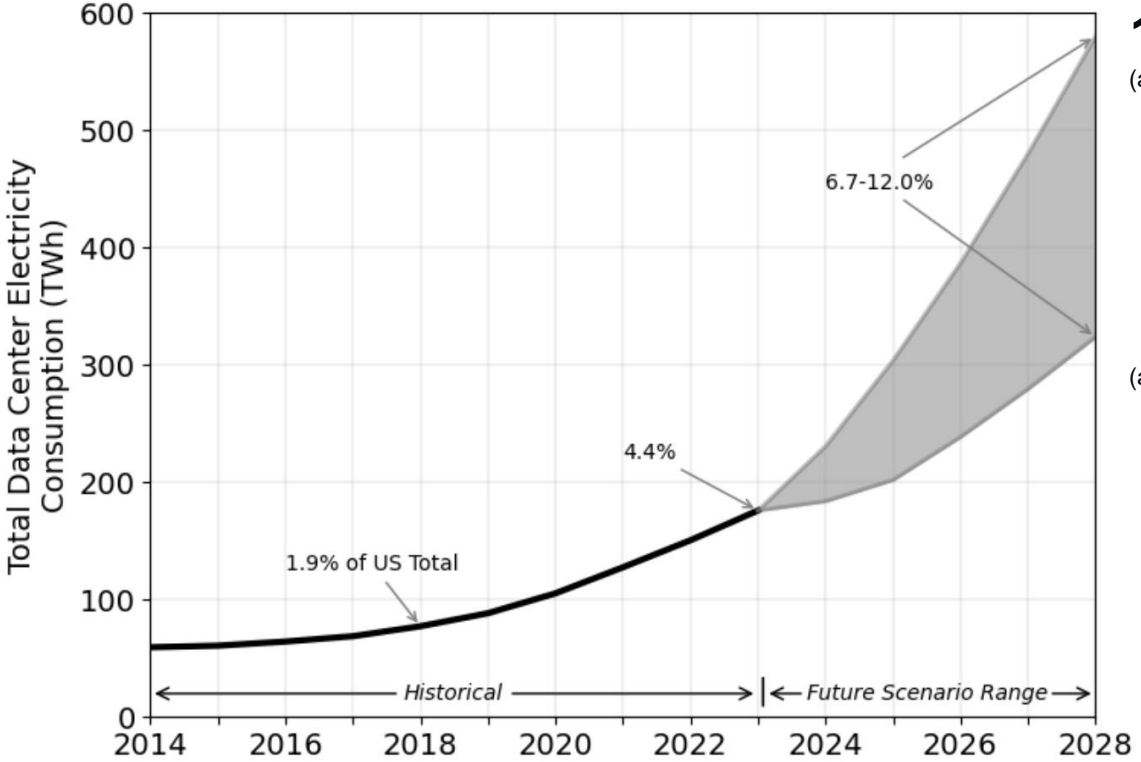
Data center load forecasts vary



132 GW
(at 50% load factor)

74 GW
(at 50% load factor)

Source: LBNL, 2024 United States Data Center Energy Usage Report (PDF). Used with permission.

Forecast uncertainty and skepticism

Demand and supply unknowns

- AI demand uncertainty
- Software improvements
  - New AI and LLM algorithms (e.g., Deepseek)
- Hardware improvements
  - New chips
  - Facility upgrades

New questions and new counterpoints

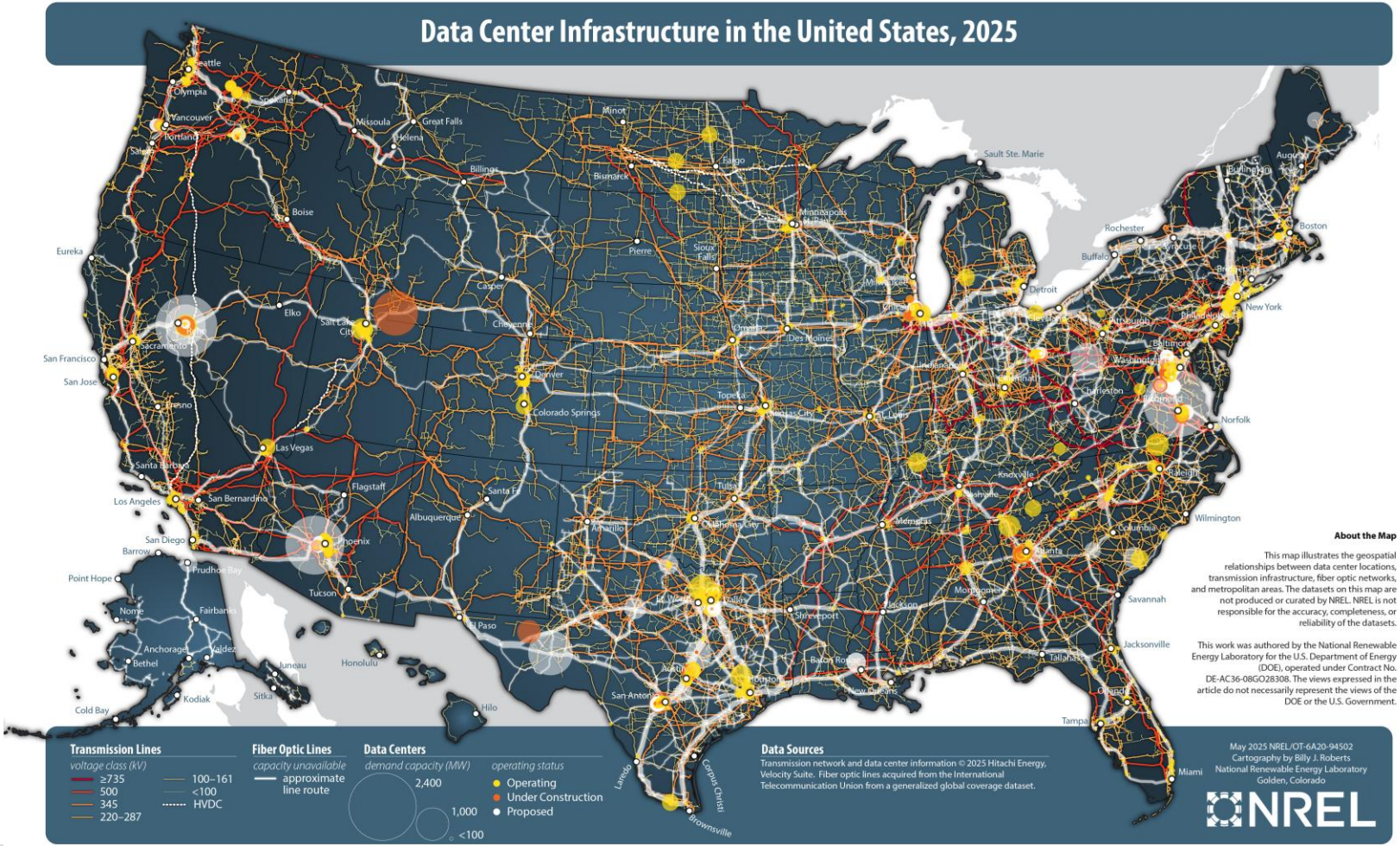
- “NVIDIA’s business plan is our growth forecast.”
- Speculative interconnection requests, shopping around
- Other sectors or sources may drive more demand growth

Headlines point to increased uncertainty…

> Microsoft says it's 'slowing or pausing' some AI data center projects —AP News

> Amazon has halted some data center leasing talks, Wells Fargo analysts say —Reuters

Source: Microsoft stock images


Data Center Infrastructure in the United States, 2025
Transmission Lines
voltage class (kV)
≥735
500
345
220–287
100–161
<100
HVDC
Fiber Optic Lines
capacity unavailable
approximate line route
Data Centers
demand capacity (MW)
2,400
1,000
<100
operating status
Operating
Under Construction
Proposed
Data Sources
Transmission network and data center information © 2025 Hitachi Energy, Velocity Suite. Fiber optic lines acquired from the International Telecommunication Union from a generalized global coverage dataset.
About the Map
This map illustrates the geospatial relationships between data center locations, transmission infrastructure, fiber optic networks, and metropolitan areas. The datasets on this map are not produced or curated by NREL. NREL is not responsible for the accuracy, completeness, or reliability of the datasets.
This work was authored by the National Renewable Energy Laboratory for the U.S. Department of Energy (DOE), operated under Contract No. DE-AC36-08GO28308. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.
May 2025 NREL/OT-6A20-94502
Cartography by Billy J. Roberts
National Renewable Energy Laboratory
Golden, Colorado
NREL

Consider forecast ranges

Source: Microsoft stock images

Don’t rely on a single forecast.

“understand the range of possible futures and identify major sources of uncertainty”

Assess different load types

“Flight risk” and “forecast uncertainty” vary by load.

Prioritize fast, affordable, flexible capital investments

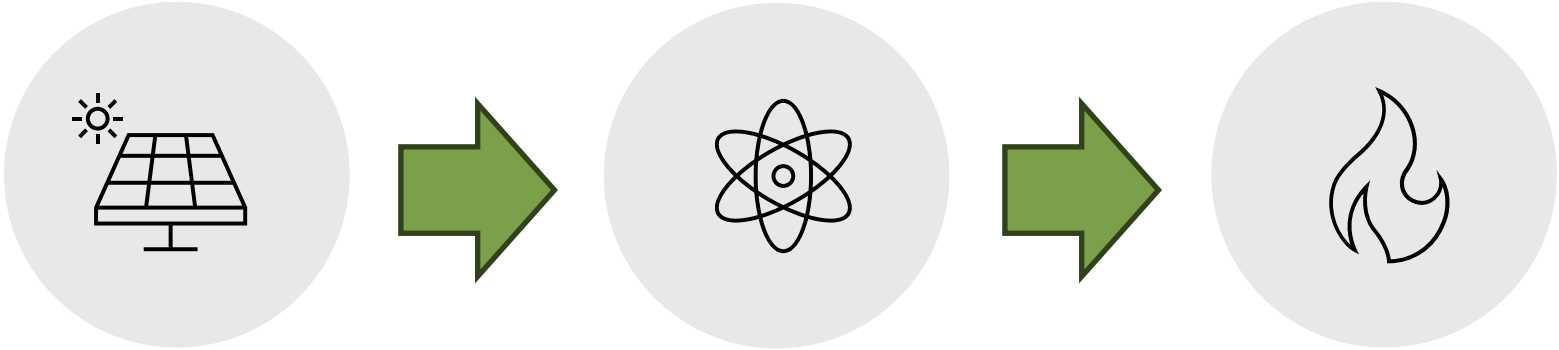
Energy efficiency, VPPs, grid-enhancing technologies, etc.

Source: RMI, Get a Load of This

“From a seat at the table, to getting the first call”

Source: Microsoft stock images

Path to power is overshadowing net-zero



Early desire focused on fully renewable

Microsoft and Constellation—Three Mile Island Nuclear

Chevron partnership to provide gas-powered capacity

Will data centers increase other customers' bills?

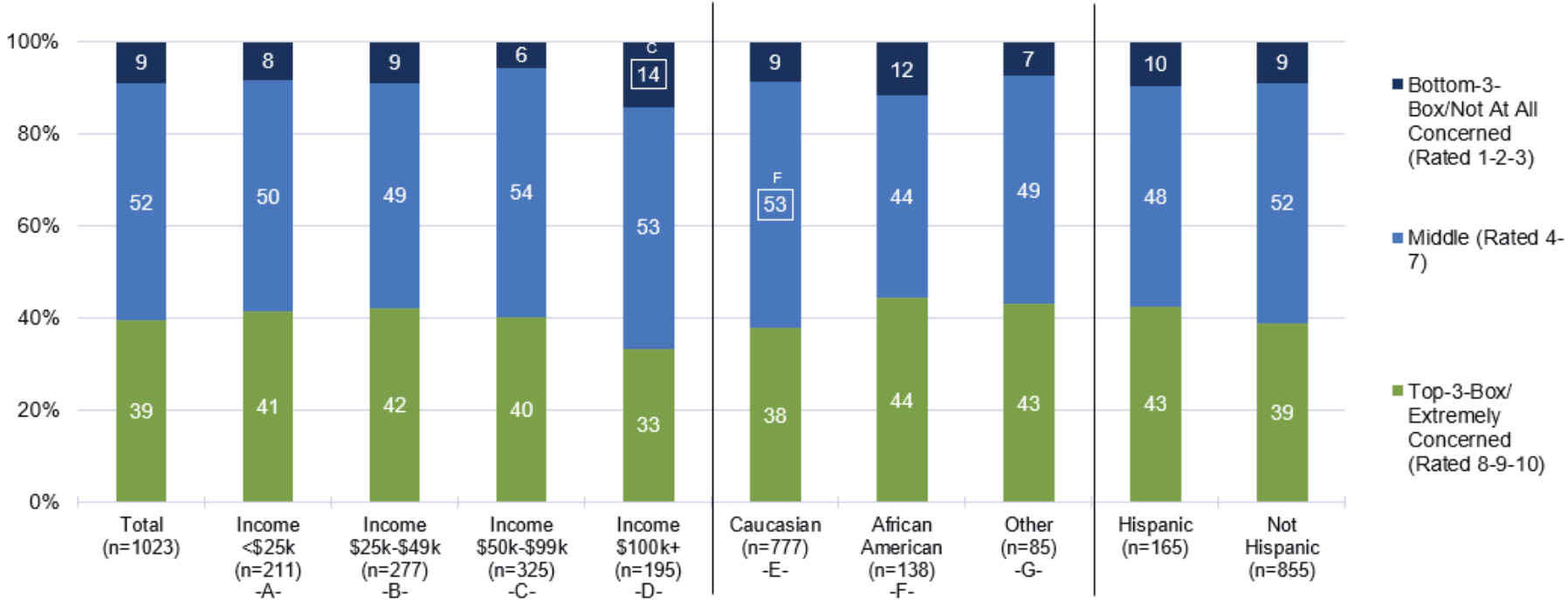
"…will likely increase system costs for all customers, including non-data center customers"

—Virginia Joint Legislative Audit and Review Commission (JLARC) report

"…additional financial risks to electric utilities and their customers because of the sheer size of the industry's energy demand"

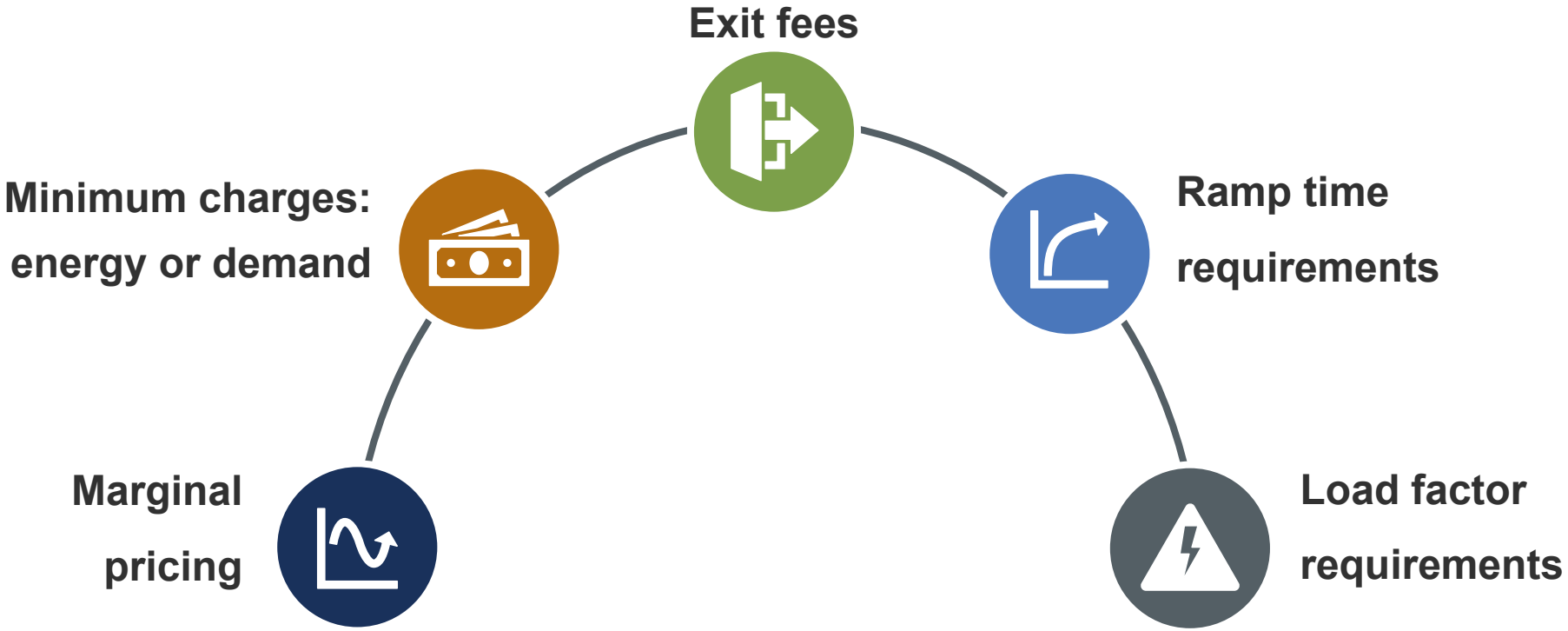
—Virginia Joint Legislative Audit and Review Commission (JLARC) report

Concern over data center energy costs leading to higher utility bills



 Base: Total Respondents **Question B4k** Data centers use a lot of energy to support artificial intelligence, and data centers are expected to grow significantly over the next five years. How concerned are you that data centers will lead to higher utility bills for you and your family? (Rated Not Concerned at All to Extremely Concerned)

Utility approaches to avoiding cost impacts on others



Perceptions are also important to data centers

Indiana Michigan Power, Amazon, Google, others agree on large load interconnection rules

Utility Dive Nov. 25, 2024

Meta Has Committed To Contribute Up To $1M A Year To Entergy's "The Power To Care" Low-income Ratepayer Support Program...

Benzinga· Dec 4, 2024

Google donates $500,000 to support energy efficiency efforts for Georgia Power customers

georgiapower.com April 3, 2025

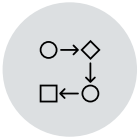
Source: Microsoft stock images

Duke University study reflects DR opportunity

Winter peak growth of 150 GW by 2034 - NAERC

76 GW could be integrated quickly with annual curtailment rate of 0.25%

Largest potential load integration could be PJM-18 GW, MISO-15 GW, ERCOT-10 GW, SPP-10 GW, and Southern Company-8 GW

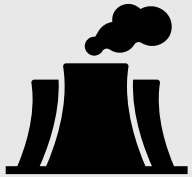


Opportunities to shift workload, use on-site generation, adjust operations

Source: Rethinking Load Growth: Assessing the Potential of Large Flexible Loads in US Power Systems

Flexibility requirements for interconnection?

Data centers want fast interconnection and time-to-power.



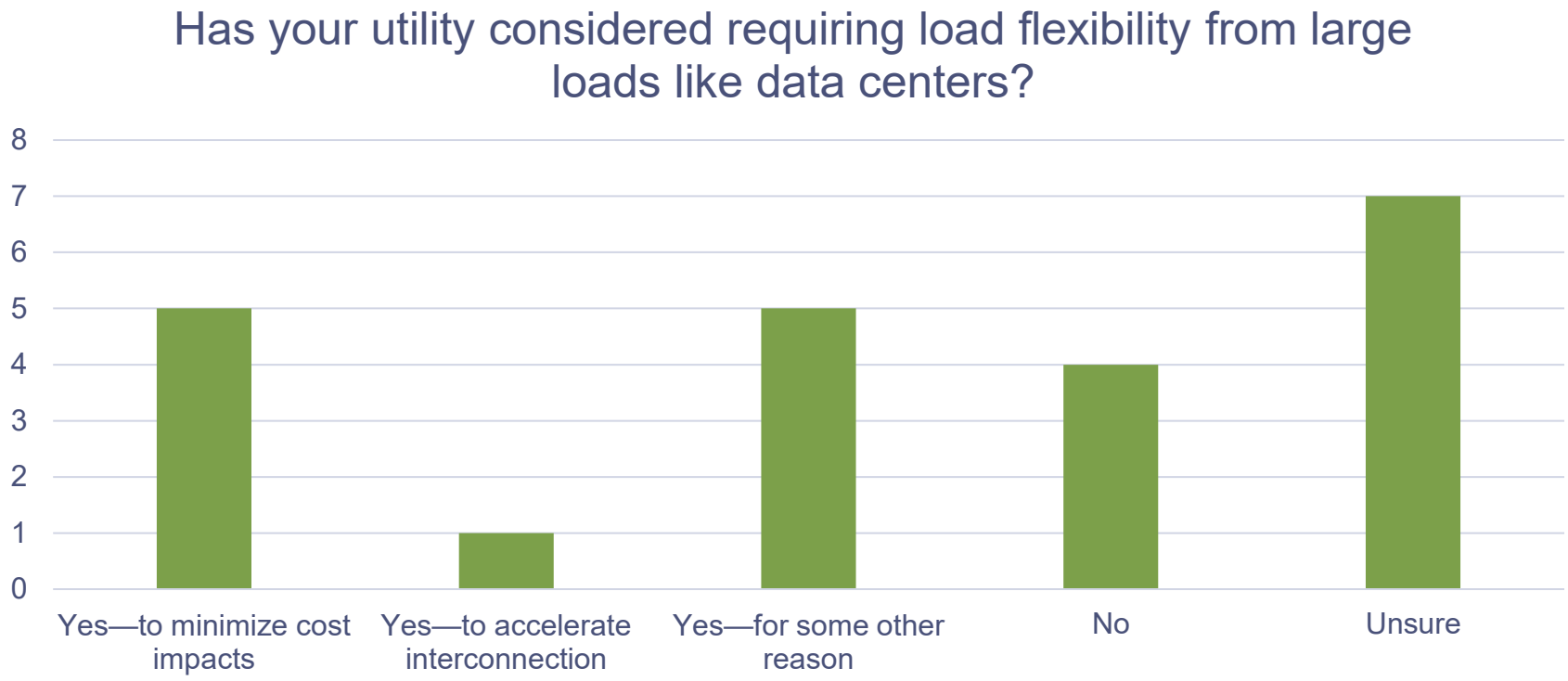
Utilities have limited capacity (sometimes).

Can load flexibility requirements help balance these?

Poll: Has your utility considered requiring load flexibility from large loads like data centers?

1) No
2) Yes—to accelerate interconnection
3) Yes—to minimize cost impacts
4) Yes—for some other reason
5) Unsure

Poll results



Existing facilities can be an opportunity

Source: Microsoft stock images

Efficiency opportunities

Cooling

- Liquid cooling
- Economizing
- Setpoint reduction
- Application- and location-specific measures

Waste heat reuse

- Colocation
- Thermal energy networks

IT improvements

- Specialized chips
  - Tensor processing unit (TPU)
  - Data processing unit (DPU)
- Scheduling and “containers”

Measuring data center efficiency

Power usage effectiveness:

$$PUE = \frac{Total\ facility\ energy\ use}{IT\ equipment\ energy\ use}$$

- Average PUE has improved
  - 2007: 2.50
  - 2023: 1.58
- Varies with facility type and owner
  - Google fleet average Q1 2025: 1.08
- PUE doesn't capture how useful or productive IT energy is
- "PUE served data centers well… but it's insufficient in today's generative AI era" —NVIDIA
- Different orgs with different goals may need different sets of metrics
  - Dozens exist

Questions

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October 6–8, 2025 • The Sheraton Denver Downtown • Denver, CO

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References and resources

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- EPRI, Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption
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References and resources

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- EPRI, Utility Experiences and Trends Regarding Data Centers: 2024 Survey
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- Uplight, The Power to Adapt: Data Center Energy Management and Load Flexibility Potential (PDF)
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- Lawrence Berkeley National Laboratory, Electricity Rate Designs for Large Loads: Evolving Practices and Opportunities (PDF)

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